TECHNICAL REPORT

Evaluation of Immunizer-Training-Immunizer Program in Maluku, Indonesia

An On-the-Job Peer Training Approach to Improving the Performance of Health Workers

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Abstract

The provincial Ministry of Health in Maluku, Indonesia, and Project Concern International undertook activities to improve the local immunization program including field surveys, a computerized information system and peer-to-peer training Well-performing immunizers gave on-the-job training to poorly performing immunizers in 15 selected health centers in 1993–94 The evaluation compared changes in key performance indicators in the year before and the year after the training between a program group and a nonprogram group over this two-year period Coverage of DPT1, polio3, and measles vaccine in the program group increased 40% in the year after the training, while remaining constant in the nonprogram group for this two-year period ($p < 001$) The result reflects increases both in actual doses and in reporting accuracy Management surveys before and after the training found improvements in the quality of immunization practices and use of new strategies to increase coverage The out-of-pocket cost was about $53 (U S) per trainee, excluding salaries of trainers and trainees, $0 05 per additional vaccination given, and roughly $0 50 marginal cost per additional fully immunized child

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Executive Summary

To increase immunization coverage and prevent childhood illness, Indonesia has devolved responsibility for immunizations at the local level to health centers, appointed a practical nurse as immunizer in each health center, and developed a system of monthly visits (called *Posyandu*) to villages to reach the population The Maluku Ministry of Health and Project Concern International jointly undertook a series of activities to enhance the provincial immunization program, including field surveys, a computerized immunization information system, and an on-the-job peer-to-peer training program The training program sent experienced, highly performing immunizers to the health centers of inexperienced, poorly performing immunizers for one to two weeks to provide on-the-job training and assistance District health officials selected both the trainee and the trainer immunizers, using information from the surveys and information system

An evaluation of the training program compared changes in key performance indicators in the year before and the year after the training between a group of 13 immunizers trained in 1993 and 1994 (program group) and a group of all 95 immunizers in the province who did not receive the training (nonprogram group) Coverage of DPT1, polio3, and measles vaccine in the program group rose about 40%, while coverage in the nonprogram group remained nearly constant over the two-year period, a highly significant difference ($p < 001$) This result reflects increases in actual doses given and in reporting accuracy, both goals of the training program Various potential threats to the validity of the study were addressed and found not to be significant

The training program improved the problem-solving skills of the trainees (such as organizing Posyandu and following up on no-shows) and improved particular techniques (such as refrigerator organization, information system form completion, and BCG vaccination technique) The out-of-pocket cost of the training program was only about $53 (U S) per trainee, which included travel and per diem expenses but not salaries of the trainers or trainees This works out to be about $0 05 per additional vaccination given The marginal cost per additional fully immunized child is estimated to be roughly $0 50

Acronyms

BASICS	Basic Support for Institutionalizing Child Survival
BCG	Bacillus of Calmette and Guerin (tuberculosis vaccine)
DPT	diphtheria, pertussis, and tetanus vaccine
EPI	Expanded Program on Immunization
FIC	fully immunized child
ITI	immunizer-training-immunizer
ORS	oral rehydration salts
PCI	Project Concern International
PVO	private voluntary organization
RP	rupiah (Indonesian currency)
URTI	upper respiratory tract infection
USAID	U S Agency for International Development
WHO	World Health Organization

Introduction

Training by peers has been proposed as an efficient, effective, and sustainable alternative training strategy to formal classroom methods of health worker training (Godwin 1983, Storms 1979, Steele 1987) Many studies demonstrate that peer-based programs can be highly effective in dealing with social and psychological problems, where peers perform as counselors, mediators between professionals and clients, trainers, or leaders of self-help groups (Silverman 1980, Thurston 1982, Tindall 1989) For example, a meta-analysis of 240 evaluations of substance abuse prevention programs found that the programs employing peer-based strategies were consistently much more effective than programs relying on other approaches such as knowledge acquisition, affectation, or attractive alternatives (Tobler 1986)

Although childhood immunizations are often considered to be the most important and successful of the many strategies for reducing child mortality and morbidity, a great deal of work remains to be done to eliminate the effects of vaccine-preventable diseases in developing countries Improvement of health worker performance is one of the keys to achieving this goal (Grabowsky 1991)

In this paper, we report the evaluation of a program in which experienced and successful nurse-immunizers provided on-the-job training to their less experienced and less successful peers This program, which was implemented in 1993 in the Maluku Province of Indonesia by the provincial Ministry of Health and Project Concern International (PCI), a private voluntary organization (PVO), was part of a more comprehensive effort by the provincial government and PCI to increase immunization coverage and improve quality (Robinson 1995) The evaluation attempts to determine the effect of the program on immunization coverage and immunizer knowledge and practice and to summarize program costs (All data tables appear in annex A)

Program Description

Indonesia's preventive health care services are largely delivered through a network of health centers, which are the next-to-smallest service areas within the hierarchy of provinces, districts, subdistricts, health service areas, and sub–health service areas Health centers use a variety of strategies to provide immunizations to women and children in their catchment areas, including monthly visits to villages and neighborhoods to weigh, educate, and immunize mothers and children (Posyandu)[1] and the creation of a special immunizer position on the health center staff to manage the health center's immunization program The immunizers, who typically have a ninth grade education, three years of nursing training in a hospital, several years of nursing experience, and a one-week government course on immunization techniques, have full responsibility for implementing the health center's immunization program, including managing the cold chain, giving vaccinations at the health center and Posyandu, recording and reporting data, and helping to organize the Posyandu In Maluku the immunizers from each district meet quarterly for several days

The immunizer-training-immunizer (ITI) program was established to provide on-the-job training to immunizers who were not performing well, as indicated by low or poorly reported coverage data, or who

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[1] The *Posyandu* is a community-supported monthly clinic that provides immunizations, growth monitoring nutrition education, vitamin A supplements antenatal care family planning and diarrheal disease control (ORS packets) for pregnant women and children under 5 years It is organized by the community and served by community volunteers with the provision of technical assistance from the local health center staff

were inexperienced The ITI program was initiated in Maluku in 1993 and implemented in 15 health centers throughout the province during 1993 and 1994 Each of the five district health offices in Maluku identified two or more health centers to receive the ITI program (referred to here as "host health centers" and "host immunizers"), and also selected the immunizers to give the trainings (referred to here as "trainers") To reduce travel costs, most of the trainers came from health centers near the host health centers and as similar to them as possible All trainings were held at the host health centers for a period of one to two weeks Usually the trainer and host immunizer were acquainted with each other before the ITI training through the quarterly district meetings, and sometimes the visiting trainer stayed in the home of the host immunizer Although neither the trainer nor the host immunizer received additional remuneration for this activity, the trainer received recognition, a paid trip to the host health center, and formal credit toward advancement

During the training, instruction and practice were provided on techniques to improve quality (e g , operation and maintenance of the refrigerator, proper storage of the vaccines in the refrigerator, injection techniques), operation of the information system, and strategies for increasing immunization coverage The latter included reinforcing knowledge that it is appropriate to vaccinate when the child is ill with fever or diarrhea, using the immunization record book during a Posyandu to identify no-shows who are due for a vaccination and tracking them down that day to give the vaccination, giving public presentations at Posyandu to inform and motivate mothers about immunizations (e g , by explaining that a slight fever in the child is normal after some vaccinations and should not be cause for failing to complete the full course of immunization), and increasing attendance at Posyandu by better scheduling, more effective use of village volunteers, and closer cooperation with community leaders and subdistrict officials

Methods

Of the 116 operational health centers in Maluku Province during 1993–94, 15 completed the ITI program, 1 initiated the training but discontinued it almost immediately, and 100 did not initiate the program in either 1993 or 1994 The program group includes the 15 health centers that completed the program, while the control includes the other 101 operational health centers (table A-1)

Various kinds of data were obtained to assess the impact and cost of the ITI program The immunization information system operated by the Maluku Province Ministry of Health yielded retrospective data on age-appropriate doses of DPT1, polio3, and measles vaccine given and reported monthly by the health centers in the 12 months before and the 12 months after the ITI training was implemented (table A-2) The vaccinations are defined as "age-appropriate" when they are given before the first birthday Measles vaccination must also be given after 9 months of age to be age-appropriate The provincial immunization information system also provided official estimates of the target population by health center catchment area in the corresponding time periods (table A-3)

Two provincewide surveys using the standard World Health Organization (WHO) 30-cluster Expanded Program on Immunization (EPI) household immunization survey methodology were completed by PCI and the Maluku Ministry of Health in 1994 and 1995, capturing vaccinations given in the two years before the surveys (PCI 1995) The results from these two surveys, which were independent of the ITI program, provided estimates of the actual immunization coverage rate in the province to compare with the estimates obtained from the provincial immunization information system [2] This comparison produced adjustments that were used to correct for overreporting of coverage by the provincial information system The derivation of the adjustments is given in annex B

PCI and the Maluku Province Ministry of Health also completed a field survey of immunization management practices in a sample of 90 health centers during the period preceding and following the ITI trainings The field survey covered many of the health centers twice several months apart Twelve of the ITI program health centers were surveyed in the months just preceding the ITI training, and nine of these also received a second survey within a year following the training The remaining three were surveyed by the authors in 1996 Although not originally designed to contribute to the ITI evaluation, these surveys provided serendipitous and independent information on changes in key immunization practices

Additional information on changes in practices following the ITI trainings was obtained from assessments completed by the ITI trainers at the start and finish of each training These assessments were available for 11 of the 15 program health centers In early 1996, the authors carried out interviews with several of the trainers, host immunizers, and district disease control officers, who have technical oversight responsibility for the immunization activities in the health centers and who played a key role in the selection of the ITI trainers and trainees We gave particular attention in these interviews to the special conditions that surrounded each of the 15 program health centers and ITI trainings and possible confounding factors that might threaten the validity of the results Finally, cost data were obtained from the PCI accounting records and are summarized in table A-4

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2 The cluster surveys provide estimates for three different definitions of coverage Vaccinations received is defined as the fraction of the children in the survey sample 12–23 9 months old at the time of the survey interview who were vaccinated by the time of the survey Vaccinated by first birthday is the fraction of sample children vaccinated by their first birthday 'Correctly vaccinated" is the fraction vaccinated according to the recommended schedule including all vaccines by the first birthday, measles after 9 months of age, and proper spacing between vaccinations The survey only counted vaccinations that were verified (including the date) by the child's health card or the health clinic's immunization registry

The number of age-appropriate doses of vaccine given monthly as reported by the health centers to the provincial information system is referred to as "Reported Doses", the estimate made by the Maluku Ministry of Health of the number of children living in a health center catchment area who should be immunized in a particular year is referred to as the "target population", and the ratio of Reported Doses (times 100) to the target population is referred to as "Reported Coverage " Reported Coverage uses administrative data to estimate both the numerator (Reported Doses) and the denominator (target population) and is to be distinguished from coverage estimates based on the health card and recall data obtained from the survey of a representative sample of children aged 12–23 months "Survey Coverage" refers to coverage obtained from the 1994 and 1995 household surveys "Adjusted Coverage" is the Reported Coverage corrected for overestimation by applying the adjustments obtained from the 1994 and 1995 household surveys

Complete data on Reported Doses were available for only 13 of the 15 ITI program health centers Further, one ITI health center split into two health centers six months before the ITI training, thus making it impossible to allocate the data on Reported Doses in the year before the split between the new and old center For this reason and because the ITI training was implemented in both the new and the old health centers in the same month, they were treated as a single case for the analysis of coverage Thus, the program group contains 13 health centers, but for purposes of coverage analysis, a sample size of 12 is used Similarly, no data were reported for 6 of the 101 health centers that did not participate in the ITI program in 1993–94, leaving 95 in the nonprogram group Although monthly data on Reported Doses were obtained for each program health center, only an aggregate figure was available for the 95 reporting nonprogram health centers, obtained by subtracting reported doses in the 15 program health centers from the total figure for the province Thus, the unit of analysis is children rather than health centers

The number of reported doses given was obtained from the immunization information system for a 24-month study period ending with the 12th month following the month in which the ITI training occurred, but the before and after ITI periods are only 11 months long The before ITI period for each program health center includes the 11-month period immediately preceding the month the training occurred, while the after ITI period includes the 11 months immediately following the month of the training Most of the trainings occurred in or around September 1993 Therefore, the before ITI period for the nonprogram group was assumed to be the 11-month period ending August 31, 1993, and the after ITI period the 11 months ending August 31, 1994

Results

Increase in Reported Doses and Coverage

In the 13 reporting program health centers, the Reported Doses for DPT1, polio3, and measles increased by 34%, 38%, and 40%, respectively, in the 11-month period immediately following the ITI training compared with the 11-month period immediately preceding the training Corresponding figures for the 95 nonprogram health centers showed essentially no change (0%, -2%, and -2% for DPT1, polio3, and measles) This yields net increases (program increase minus control increase) of 34%, 40%, and 42% for Reported Doses of DPT1, polio3, and measles A composite indicator obtained by summing up the Reported Doses for all three vaccines shows a 37% gain in the program group compared with a 1% drop in the nonprogram group The difference between the program and nonprogram children is highly significant for all three antigens and their composite, but the difference among antigens is not significant, as shown in table 1, which is based on data in tables A-5 and A-6

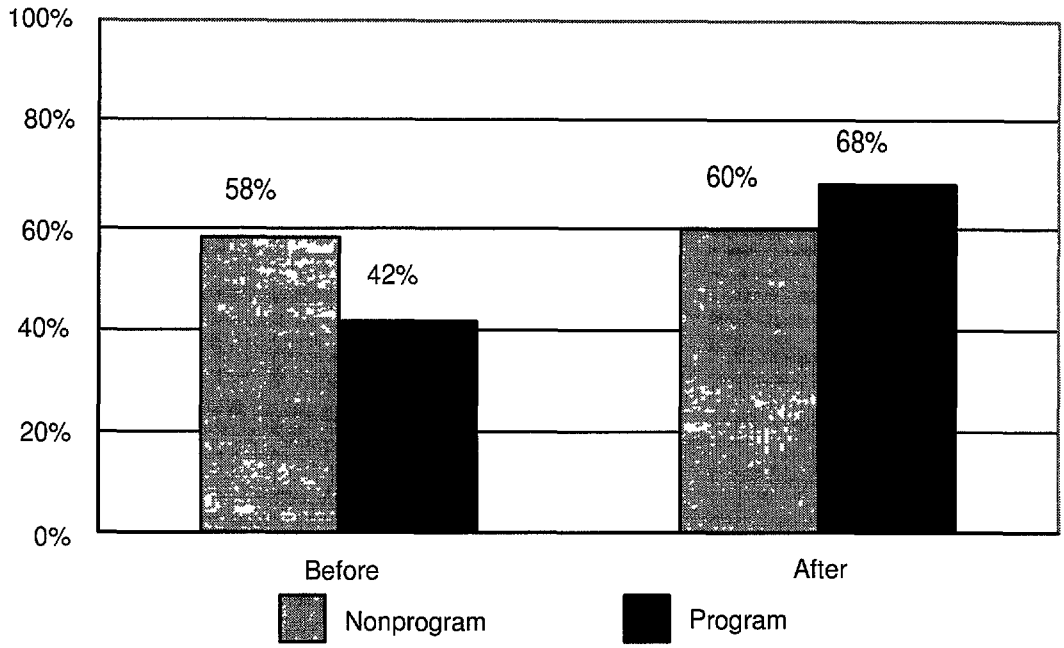
Provincewide coverage from the 1994 and 1995 household surveys is about 23 percentage points lower for all antigens than the corresponding Reported Coverages from the immunization information system The reasons for this difference between Survey Coverage and Reported Coverage are unknown but could include many factors, such as inappropriate reporting of doses given to children over 1 year of age, inconsistent reporting and overreporting, missed immunizations in the coverage survey, and, what is probably most important, underestimation of the target population When these results are combined with the Reported Doses and target population data from the information system, the Adjusted Coverage estimates are obtained, as shown in tables 1, A-5, and A-6 and figure 1 Adjusted Coverage in the program health centers rises dramatically but remains very small in the nonprogram health centers For example, measles coverage increases from 35% to 61% in the program health centers, but only from 50% to 51% in the nonprogram health centers, a net percentage gain of 36% and a net percentile gain of 21 The composite indicator showed a net gain of 60% in Adjusted Coverage

Table 1 Impact of ITI Program Actual and Potential

	Actual Effect All 13 Program Health Centers		Potential Effect 11 Program Health Centers	
Net percentage gain in Reported Doses				
Composite	38%		47%	
	Before	After	Before	After
Adjusted coverage				
DPT1 (program)	49%	76%	49%	83%
Polio3 (program)	41%	68%	40%	76%
Measles (program)	35%	61%	34%	67%
Composite (program)	42%	68%	41%	75%
Composite (nonprogram)	58%	60%	58%	60%

Note The actual effect is based on all 13 program health centers and potential effect on the 11 program health centers with functioning transportation systems in the year after the ITI training

Figure 1
Adjusted Immunization Coverage Composite of DPT1 Polio3 and Measles



When figures for Reported Doses are disaggregated by health center, there is a consistent increase across the program health centers with two exceptions, as seen in table A-6 There were positive gains in all three antigens in Reported Doses in 9 out of the 12 program health centers In the two program health centers showing decreases in two or three antigens, one (Dofa) reported that its motorboat broke down just after the ITI training, which prevented its immunizer from visiting many coastal villages for the next 10 months, and the other (Wairoro) reported that its vehicle caught fire and burned two months after the ITI training, causing them to miss many Posyandu In addition, floods six months later wiped out several bridges, further restricting Posyandu participation by the immunizer These transportation breakdowns appear to be responsible for the lack of improvement in the two program failures If these two centers that experienced transportation system breakdowns are dropped from the analysis, the effect of the program is larger The net gain in the composite of Reported Doses increased by 47% with functioning transportation systems compared with a 38% net increase in all 13 reporting program health centers This result might be viewed as the potential of the ITI program under ideal conditions, or at least in systems with adequate transportation The estimates of actual program effectiveness (based on all 13 program health centers) and potential effectiveness (based on the 11 centers with adequate transportation) are shown in table A-7

In addition to a consistent improvement in absolute scores, the ITI program health centers also showed a consistent improvement in their ranking relative to other health centers The ranking of each program health center just before ITI training was compared with its ranking six months later using a six-month composite coverage score of all three antigens All 15 program health centers improved their rank within their own district, 10 of the 15 moved from the bottom half to the top half of the health centers in their district, and the average overall increase was 35 percentage points (table A-8)

Improvement in Practices

Immunization practices improved in the program health centers following the ITI trainings according to the field study of immunization management practices and the assessments made by the trainers before and after the ITI trainings In the field survey of management practices, data were obtained from 12 of the program health centers on 12 key practices The average number of those practices performed correctly rose from 7 4 in the before ITI survey to 10 2 in the after ITI survey, an increase of about 30% The largest gains occurred in the practice of giving immunizations to children who are sick with fever, diarrhea, or upper respiratory tract infections (URTI) In the after ITI survey, 8 of the 12 health centers performed over 90% of the practices correctly, while all but one performed over 75% of them correctly The data from the management practices surveys are in table A-9 The before and after assessments by the ITI trainers mirror these results The average number of correctly performed practices (out of 8) rose from 5 1 at the start of the training to 6 6 at the end—an increase of 29% Table A-10 presents the results of the ITI trainer assessments

Threats to Validity

Training Month

There are several possible threats to the validity of the results reported above One such threat—the possibility that the Reported Doses during the training month are unduly high or low as a result of the training—was eliminated by removing the training month from the analysis The training itself might reduce the number of vaccinations given during the training visit because the immunizer spends all available time learning management techniques related to the cold chain or the information system, or conversely, the number of vaccinations might increase through special outreach efforts by the trainer and host immunizer during the training visit In fact, Reported Doses in the month of the ITI training were substantially higher than Reported Doses in the same month one year later (21%, 20%, and 6% higher for DPT1, polio3, and measles, respectively) This suggests that the presence of the trainer added an additional increment to the increase in coverage during the training month over and above the more sustainable impact that was observed during the following year

Staffing Patterns

Two threats relate to changes in immunizer resources during the data collection period, including the replacement of one immunizer with another and the allocation of more (or less) staff time to the immunizer function A change of immunizers might enhance performance (e g , a new and energetic immunizer replaces an older immunizer who rarely visited the villages) or hinder it (e g , the new immunizer is less experienced than the previous one) Similarly, a change in the amount of staff time devoted to the immunizer function could enhance performance (e g , hire an assistant immunizer) or hinder it (e g give the existing immunizer an additional job) In fact, six program health centers replaced their immunizer during the 24-month data collection period, one added a full-time assistant immunizer just after the training, and one eliminated a part-time assistant immunizer position after the ITI training Only five of the six centers that replaced their immunizers were among the 13 with complete Reported Doses data The seven program health centers that kept the same immunizers had a significantly larger gain in Reported Doses than the five that replaced them This difference would have been even larger if

the two centers without transportation were removed from the analysis, as seen in table A-11 Thus the effect of the ITI program might have been larger if all the program health centers had kept the trained immunizers on the job following the training

Because only two program health centers changed the amount of staff time allocated to the immunizer function during the data collection period—one increasing and one decreasing it—it is difficult to draw firm conclusions The sparse data available suggest that this factor influences performance in accordance with expectations The composite of Reported Doses increased 123% in the one health center (Waisala) that increased its staff time, while the health center (Debut) that decreased staff time allocated to the immunizer function experienced an increase of only 20% (table A-11) However, this potential influence does not have a material effect on the previous conclusion because the number of Reported Doses in these two health centers is small compared with the total for all the ITI program health centers and because the effects of the two tend to cancel each other out

Seasonal and End-of-Year Effects

Two possible threats relate to the annual calendar, including seasonal patterns due to weather and end-of-fiscal-year effects The use of identical 11-month periods for the before and after ITI data points avoids systematic bias due to seasonal patterns Another potential problem is the late reporting of data near the beginning or end of the evaluation periods Health centers sometimes fail to report doses given for one or two months and then heap them into a single month for reporting purposes A month-by-month review of the data for the program health centers revealed no such heaping around the beginning or end of the 11-month data collection periods for any of the program health centers

Improved Reporting versus Increased Coverage

A major confounding issue is the extent to which the observed increases in Reported Doses and Adjusted Coverage are due to an improvement in reporting rather than to an increase in the number of age-appropriate doses actually given In fact, the ITI program has both objectives—increase actual coverage and improve the reporting The data obtained for this study does not permit the untangling of these two factors, and so it is not possible for us to estimate how much of the observed increase is due to improved reporting and how much to actual increases in doses given However, there is strong anecdotal evidence that both factors contributed to the increase For example, two health centers (Benteng and Waisala) were selected for the ITI program specifically for the purpose of improving their reporting function Another program health center modified its reporting procedure following the training to count doses given by a nearby hospital to children living in the health center catchment area Both of these examples support the conclusion that some of the increase in Reported Doses was due to changes in reporting

In support of an increase in actual doses given, several host immunizers recounted specific strategies they learned at the ITI training, which they then used and which in their opinion substantially increased the number of doses they gave For example, some of the strategies mentioned included following up with no-shows and working with village volunteers to increase Posyandu attendance These observations were confirmed by medical staff at the health center and by district health officers In addition, the field study of immunization management practices and the before and after ITI assessment of host immunizers' knowledge and practice by the trainers provide objective evidence of improvements that are likely to have increased coverage For example, the field study found that the percentage of program health

centers that vaccinated children with fever, diarrhea, and URTI more than doubled after the training, and program health centers that opened a new vial of vaccine when only one child showed up for a Posyandu increased by about 40% The trainers' assessments reported a substantial increase in the number of host immunizers who kept track of the children due for a vaccination at a Posyandu and went to get them if they did not show up

Regression-toward-the-Mean

Another concern arises from the fact that the health centers in the program were selected because of poor performance This opens the possibility of regression-toward-the-mean as an explanation for their subsequent improvement However, monthly data on Reported Doses show that program health centers ranked consistently low in their respective districts month after month, but after the ITI training their ranking was consistently higher month after month Therefore, the chronic nature of the poor performance before and good performance after the ITI training makes it unlikely that regression-toward-the-mean is an important contributor to the increase

Cost and Cost-Effectiveness

The average out-of-pocket cost of each immunizer training was about $53 (U S) This includes all expenses for travel and per diem It does not include salaries of either the trainer or the host immunizer, which would have been paid anyway The cost per training ranged from $16 to $134, depending on the duration of the training (from 3 to 12 days) and cost of travel This works out to about $2 12 (U S) for each 1 percentile increase in Adjusted Coverage [3]

Each health center provides eight different childhood vaccinations (BCG, DPT1/2/3, polio1/2/3, and measles) Using simplifying assumptions,[4] we estimate that the number of reported doses of all kinds increased by 12,745 in the 13 program health centers in the year following the ITI program as a direct result of that program This works out to about $0 05 for each additional dose reported and $0 40 to provide eight additional vaccinations, the package required to complete all immunizations for one child If half of this increase is due to an increase in actual doses given, as opposed to an improvement in reporting,[5] then the training cost per additional dose given in the following year is about $0 10 and about $0 80 to provide all eight required vaccinations [6] These estimates will be cut in half if the impact of the ITI program is assumed to continue for two years instead of just one, and so on

Another way to present costs is by fully immunized child (FIC) [7] Using our estimate of a 40% increase in reported performance, we estimate that the ITI program increased reported FICs in the program health centers by about 40%—from 2,898 in the year before the training to 4,057 in the year after The Maluku Baseline Survey (PCI 1995) estimated that measles coverage by the first birthday was 57%, and full coverage (BCG, DPT1/2/3, polio1/2/3, measles) by the first birthday was 47%, 10 percentage points below what the survey found for measles coverage This information (47% full coverage before ITI program and 40% increase in reported FICs) plus a target population of 6,165 before the program yields an ITI training cost of $0 59 per additional reported FIC assuming one year of impact [8] The estimated cost per additional FIC actually achieved (rather than reported) depends on the amount of the reported increase that comes from an actual increase rather than improved reporting, and on the number of years that the impact of the program is sustained Figure 2 displays the marginal out-of-pocket cost of an

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3 The marginal cost per percentile increase in Adjusted Coverage is obtained by dividing the average marginal cost of the program ($53) by the net percentile gain in Adjusted Coverage which is $53/25 = $2 12

4 The average increase in total Reported Doses given of all eight vaccinations in the year following the ITI training is assumed to equal all Reported Doses in the year immediately preceding the ITI training multiplied by 40% the average gain due to the ITI program The gain in annual Reported Doses is assumed to equal twelve elevenths (12/11) of the gain between the two 11-month study periods and Reported Doses for all eight vaccinations are assumed to equal eight thirds (8/3) of Reported Doses in the three measured vaccinations Thus gain in all reported doses in 13 ITI centers = 10,953 x 12/11 x 8/3 x 0 4 = 12 745 The training cost per additional dose reported is estimated as ($53 x 13)/12 745 = $0 05 This assumes the improvement in immunizer performance lasts only one year

5 Based on the interviews and the situations in the program health centers the authors believe that this is a very conservative assumption, and that in fact well over half of the increase in Reported Doses is due to an increase in actual doses given

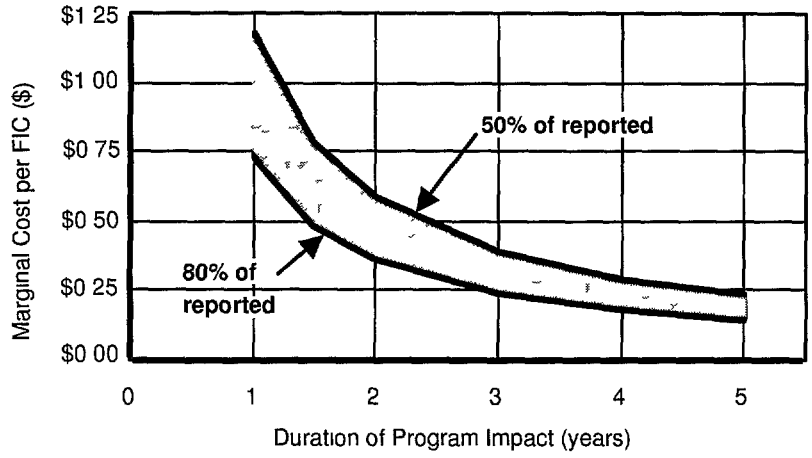
6 This cost would be even less and the potential impact of the program even greater if additional vaccinations such as hepatitis B birth OPV or tetanus were given

7 A fully immunized child is defined as a child who has received all eight of the recommended vaccinations (BCG DPT1/2/3 polio1/2/3 measles) by his or her first birthday (Brenzel and Claquin 1994)

8 FICs before the training = (Target Population) x (coverage) = 6,165 x 12/11 x 0 47 = 2,898 FICs after the training = (FICs before) x (increase factor) = 2 898 x 1 4 = 4 057 Out of-pocket cost per additional reported FIC per one year of impact = $53 x 13 / (4 057 2 898) = $0 59

additional FIC for a duration of impact from one to five years and an actual increase that ranges from 50% to 80% of the reported increase This yields a marginal cost range of $0 15 to $1 18 The results in figure 2 suggest an estimate of roughly $0 50 as the marginal out-of-pocket cost per additional FIC, which occurs for an impact duration of about two years Table 2 summarizes these results

Figure 2
Marginal Cost for Each Additional Fully Immunized Child Gained from ITI Program



Note Marginal cost per additional fully immunized child (FIC) from the immunizer training program as a function of duration of program impact and ratio of actual to reported increase in FICs which is assumed to range from 50% to 80 / The graph assumes that the number of reported FICs increases by 40 / as a result of the program Marginal cost per FIC = 0 59 / (R x T) where R is the ratio of actual to reported improvement and T is the duration of the program in years

Table 2 Cost-Effectiveness of ITI Program

Indicator		Cost (U S)
1	Average cost per immunizer trained	$53 00
2	Average cost per 1 percentile rise in coverage per health center	2 12
3	Average cost per additional vaccination given (assumes 1 year impact and 0% due to reporting)	0 05
4	Average cost per full complement of vaccinations (8 in all) (assumes 1 year impact and 0% due to reporting)	0 40
5	Approximate average cost per FIC (assumes about 2 years impact and 40% due to reporting)	0 50

Note Costs are out of pocket only and include travel and per diem of trainers but not salaries of the trainers or trainees or any other marginal or opportunity costs Duration of impact in years refers to the number of years that the effect of the ITI training lasts on the trainee The percentage due to reporting refers to the percentage of the observed increase in reported doses or coverage that is due to reporting as opposed to the percentage due to an actual increase

Discussion

The Government of Indonesia has turned to nurse-immunizers to manage and implement the national immunization program at the local level In Maluku Province, the Ministry of Health and PCI implemented a peer-to-peer on-the-job training program to help inexperienced and poorly performing immunizers in 15 health centers in 1993 and 1994 The program has two goals—to increase coverage and improve quality, where quality includes such practices as adhering to cold chain protocols, sterilizing instruments, and recording and reporting accurately and completely The evaluation of this ITI program concludes that it significantly improved both quality and coverage in the program health centers

The evaluators compared the increase in coverage in 13 program health centers to corresponding data for 95 health centers in Maluku that did not participate in the program and for which immunization data were available To estimate change in coverage over a two-year period, the evaluation used the change in number of doses of DPT1, polio3, and measles vaccine given to children at the appropriate age as reported in the provincial health department's administrative information system for immunizations (Reported Doses), and the change in Adjusted Coverage (Reported Doses divided by the target population for each health center adjusted for overestimation) The results showed a net increase of about 38% in Reported Doses in the program health centers relative to the nonprogram centers Furthermore, the increase was consistent across antigens and, with two exceptions, across health centers When the two exceptions resulting from transportation breakdown following ITI training are dropped from the analysis, net increase in Reported Doses is 47%—the potential impact of the ITI program In summary, the program is estimated to have increased Reported Coverage by about 40% in participating health centers

An independent field survey of immunization management practices in 90 Maluku health centers and before and after ITI training assessments of the host health centers by the trainers themselves provided strong anecdotal evidence that practices related to quality and coverage improved as a result of the ITI training For example, improvements in adherence to cold chain protocols, sterilization, reporting performance, vaccinations to sick children, and far more energetic problem-solving approaches to find and vaccinate children in the villages were observed and reported in many of the ITI program health centers The success of on-the-job peer-to-peer training of health workers to improve the teaching of cognitive strategies for problem-solving (as opposed to routine technical procedures) has been observed elsewhere (Godwin 1983), and the results reported here support the conclusion that such training is a good way to teach problem-solving However, contrary to Godwin's findings, the ITI program also improved routine technical skills, such as sterilization and proper arrangement of vaccines in the refrigerator

In addition to the ITI program, numerous other factors might have contributed to the observed increase in doses reported, including improved reporting, change in immunizer personnel seasonal effects, other components of the immunization program, data heaping due to delayed reporting, one-time campaigning or drop-off effects during the training period, and regression-toward-the-mean However, except for improved reporting, these other potentially confounding factors did not contribute to the observed program impact and in some cases may have caused the observed increases to appear smaller than they really were It can be concluded that the observed increase in coverage was due to the combined effect of improved reporting and an increase in actual coverage brought about by the ITI program Although we were not able to untangle the relative contribution of these two factors from the data available, there is convincing evidence based on the interviews and the improvement in practices that the number of doses actually given increased substantially in most cases and the reporting improved in a few cases as a direct result of the ITI program

Thus, the issue arises as to the validity of the two indicators of performance used in the study namely, gain in Reported Doses and gain in Adjusted Coverage Because the goals of the Maluku Ministry of Health for the ITI program included both improving actual coverage and improving reporting performance, the confounding of the two is not a problem from the department's perspective The reliability of the two indicators is another issue In theory, the coverage indicator should be superior to the number-of-doses indicator because it has a denominator reflecting the target population However, the estimates of the target population of health centers are made at the national and provincial levels, using standard procedures for allotting national population projections to the local level, which inevitably produces unreliable estimates Hence, estimates of coverage for health center catchment areas contain two random variables, one of which is admittedly unreliable Consequently, the number of doses given is likely to be a more reliable indicator of change than coverage at the health center level Furthermore, the proportional *change* in doses given in a health center area is likely to be the same as the proportional *change* in coverage for that health center when the target population is fairly stable from one year to the next and when most of the vaccinations given to children in the health center area are given by the health center team These two assumptions generally hold in the program health centers

The 40% increase in performance was achieved in a sample of poorly performing health centers, as indicated by lower Adjusted Coverage in the program health centers in the year before the ITI training (41%) than in the nonprogram health centers (58%) Therefore, the ITI program is not likely to produce a similar increase in all health centers Additional experience is needed to estimate the value of the program with higher performing health centers

The data available through the computerized immunization information system developed and implemented by the Maluku Ministry of Health and PCI are a vital component of the ITI program Reported Coverage by health centers was used to identify the immunizers in need of training and the immunizers capable of carrying it out The subsequent changes in Reported Doses were used to determine if the training had been successful The importance of objective performance data to the success of peer-to-peer training has been observed by other authors as well (Thurston 1982)

Conclusion

The program has been very popular with the participants and managers at the host health centers The host immunizers talk enthusiastically about their experience Several noted that it is much easier to learn in the ITI program than in "official" training courses because it is practical and addresses the real problems they face and because they can admit what they do not know to a colleague forthrightly in a way they would never do in a formal classroom setting

The out-of-pocket cost of the program was very low, averaging $53 (U S) per immunizer trained, not counting the wages of either the trainer or host immunizer or costs associated with higher coverage This works out to about $0 05 per additional Reported Dose given and about $0 50 per additional FIC As a result of the low cost and apparent success, other district and provincial governments have made plans to continue the program under their own budgets

Using cost data from immunization programs in eight countries, Brenzel and Claquin (1994) estimate that the average cost per FIC is about $15 in 1987 U S dollars, about 10% of which is for vaccines However, they note two weaknesses with this result First, the use of FIC as the unit of effectiveness does not

reflect the value of partial immunization, of vaccinations after the first birthday, or of the relative importance of the different diseases vaccinated against Second, the use of *average* cost provides no information about *marginal* cost, which is important for program design and management Further, there is a paucity of information about marginal costs of immunization programs in the literature Both of these weaknesses limit our ability to compare the cost-effectiveness of the ITI program to other interventions It is not clear whether our rough estimate of $0 50 for the marginal out-of-pocket cost of an additional FIC from the ITI program represents the full marginal cost of an additional FIC, or whether other factors such as the cost of vaccines should be included In any case, the marginal cost of each additional FIC obtained by the ITI program is very small compared with the $15 average cost estimated by Brenzel and Claquin, whether or not vaccines are included in the marginal cost

In sum, this was a very successful program It significantly increased the performance of poorly performing health workers at a low cost, using local resources The provincial Ministry of Health is continuing the program with its own funds On-the-job peer-to-peer training is a strategy that should be applied more widely

Acknowledgments

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Annex A. Data Tables

Table A-1 Health Centers in Maluku Province in 1993 and 1994

District and Health Center	In ITI Program	Missing Data	District and Health Center	In ITI Program	Missing Data	District and Health Center	In ITI Program	Missing Data
Southeast Maluku District			North Maluku			Central Maluku		
1 Adaut		X	1 Bacon			1 Airbuaya		
2 Banda Eli		X	2 Bere Bere			2 Alang		
3 Danar	X		3 Bobomg			3 Amahei	X	
4 Debut	X		4 Daruba			4 Banda		
5 Dobo			5 Dofa	X		5 Booi		
6 Elat			6 Galela			6 Bula		
7 Jerol	X	X	7 Gambesi			7 Geser		
8 Larat			8 Ibu			8 Hila		
9 Letwurung			9 Jailolo	X		9 Hitu		
10 Mesiang		X	10 Kalumata			10 Ihaluhu		
11 Ohoira			11 Kalumpang			11 Kairatu		
12 Romean			12 Kao			12 Kataloka		
13 Rumat	X		13 Kayoa			13 Leksula		
14 Saumlaki			14 Kedi			14 Letwaru		
15 Seira			15 Kotip			15 Maku		
16 Serwaru			16 Mafa			16 Masohi		
17 Taberfane	X	X	17 Malifut			17 Namlea		
18 Tepa			18 Obi			18 Namrole		
19 Toyando Yamtel		X	19 Sahu			19 Negeri		
20 Tual			20 Saketa	X		20 Lima		
21 Tubial Kur			21 Sanana			21 Pasahari A		
22 Un			22 Siko			22 Pasahari B		
23 Wakol			23 Sulamadaha			23 Pelauw		
24 Weduar			24 Tobelo			24 Piru		
25 Wonreli						25 Porto Haria Saparua		
Central Halmahera			Ambon Municipality			26 Sirisori		
1 Bicoli		X	1 Air Salobar	X		27 Suli		
2 Buli			2 Amahusu			28 Taniwel		
3 Dodaga			3 Benteng	X		29 Tehoru		
4 Dorosagu		X	4 Hative Besar			30 Tomalehu		
5 Galala			5 Hutumuri			31 Tulehu		
6 Lolobata			6 Karpan			32 Waai		
7 Ome			7 Kayu Putih			33 Wahai		
8 Patani	X		8 Kusu Kusu			34 Waimital		
9 Payahe			9 Lateri			35 Waipia	X	
10 Soasiu			10 Latuhalat			36 Waisala	X	
11 Subaim			11 Nania			37 Werinama		
12 Tomalou			12 Passo					
13 Wairoro	X		13 Rijali					
14 Weda			14 Rumah Tiga					
			15 Tiahahu					
			16 Waihaong					

Note Of the 116 health centers with immunizers in Maluku Province in 1993–94 13 participated in the ITI program and also had complete immunization data (Danar Debut Rumat Patani Wairoro Dofa Jailolo Saketa Air Salobar Benteng Amahei Waipia Waisala) 2 participated in the ITI program but did not have complete immunization data (Jerol Taberfane) and 6 that did not participate in the ITI program did not have complete immunization data (Adaut Banda Eli Mesiang Toyando Yamtel Bicoli Dorosagu) Rijali briefly started the ITI program but did not complete it Danar and Rumat merged just after participating in the ITI training

Table A-2 Reported Monthly Doses Given by ITI Program Health Centers

		Air Salobar			Amahei			Benteng			Danar			Debut			Dofa			Jailolo			Jerol		
		D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M
1992	APR				20	11	10																		
	MAY				35	28	27																		
	JUN				38	29	25																		
	JUL				59	42	30	20	3	14															
	AUG				12	15	18	48	27	23															
	SEP	30	24	17	30	8	28	41	33	23										34	61	89			
	OCT	53	25	35	58	31	20	40	40	21	—	—	—	34	27	31				39	25	41	0	0	0
	NOV	55	26	22	58	36	54	31	41	19	—	—	—	32	14	10				191	175	169	0	0	0
	DEC	26	41	21	8	10	9	64	59	48	—	—	—	6	3	1				196	179	172	0	0	0
1993	JAN	31	46	50	140	96	195	34	47	58	—	—	—	15	16	7	72	25	23	57	45	40	0	0	0
	FEB	31	39	41	45	119	57	54	64	92	—	—	—	23	9	10	5	30	13	37	30	22	0	0	0
	MAR	20	13	23	48	143	60	21	17	10	—	—	—	5	9	11	68	134	114	2	42	34	0	0	0
	APR	44	24	18	37	10	17	46	50	29	8	7	4	11	4	0	39	32	34	35	29	21	0	0	0
	MAY	17	18	14	48	37	35	38	39	24	5	4	3	5	8	12	30	29	28	39	32	25	0	0	0
	JUN	41	33	38	82	48	53	53	39	23	6	5	5	8	10	0	16	24	15	37	28	17	0	0	0
	JUL	37	26	23	80	65	59	46	50	25	42	13	19	17	4	14	50	25	32	19	19	14	0	0	0
	AUG	50	31	13	60	30	35	57	46	39	26	1	9	23	13	10	69	43	30	62	66	60	0	0	0
	SEP	26	23	17	103	115	59	47	44	33	4	24	9	13	5	3	70	50	39	44	62	51	0	0	0
	OCT	38	35	24	224	245	221	24	41	18	10	11	7	12	40	9	68	52	52	25	12	23	37	0	26
	NOV	54	44	51	7	9	23	26	43	45	22	19	5	15	40	8	47	44	48	57	39	47	79	0	18
	DEC	25	36	24	23	25	33	32	34	39	6	4	4	7	12	7	131	148	118	55	52	42	0	0	0
1994	JAN	39	32	20	43	87	71	65	57	69	5	5	11	9	10	8	39	49	29	57	45	40	0	0	0
	FEB	48	33	68	120	104	80	42	29	33	36	31	19	37	17	17	41	45	51	37	30	34	0	0	0
	MAR	49	43	50	25	32	35	45	33	25	35	31	17	11	7	4	126	129	130	2	42	34	0	0	0
	APR	35	38	21				47	31	27	20	0	7	8	23	19	51	63	29	102	107	95	6	11	5
	MAY	34	27	26				34	38	21	12	2	10	12	17	7	79	28	33	140	151	137	14	10	8
	JUN	25	34	21				40	37	15	21	7	7	16	8	9	19	16	27	178	198	182	11	6	11
	JUL	31	40	24							17	6	2	10	13	13	45	52	36	221	243	227	6	3	6
	AUG	40	53	67							18	10	1	17	28	12	31	47	22	257	284	266	20	17	17
	SEP										10	23	11	21	19	15	47	8	29				15	21	19
	OCT																29	2	12						
	NOV																48	15	25						
	DEC																172	53	81						
1995	JAN																								
	FEB																								
	MAR																								
	APR																								
	MAY																								
	JUN																								
	JUL																								
	AUG																								
	SEP																								
Sum 1st 12m		435	346	315	551	568	533	490	459	384	91	54	49	192	122	109	665	636	546	748	731	704	0	0	0
Sum 2nd 12m		444	438	413	852	807	721	505	483	389	212	149	101	175	234	128	727	507	504	1175	1265	1178	188	68	110
Sum 1st 11m		385	315	302	503	425	473	437	420	361	87	30	40	179	117	106	534	488	428	686	665	644	0	0	0
Sum 2nd 11m		404	385	346	827	775	686	465	446	374	202	126	90	154	215	113	555	454	423	918	981	912	173	47	91

Note D1 = DPT1 P3 = Polio3 M = Measles Shaded rows are months in which ITI training occurred Dashes indicate that clinic was not then in existence

Table A-2 Reported Monthly Doses Given by ITI Program Health Centers (continued)

		Patani			Rumat			Saketa			Taberfane			Waipia			Wairoro			Waisala		
		D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M	D1	P3	M
1992	APR																					
	MAY																					
	JUN																					
	JUL																					
	AUG																					
	SEP																					
	OCT	6	6	5	41	34	26	13	12	19	0	0	0									
	NOV	22	8	6	38	17	17	0	0	0	0	0	0									
	DEC	28	18	22	31	27	36	20	21	14	0	0	0	3	6	4						
1993	JAN	29	16	16	0	37	13	27	19	19	0	0	0	7	0	14						
	FEB	16	24	9	5	39	63	9	33	28	0	0	0	33	30	17						
	MAR	23	17	15	0	5	24	3	10	8	0	0	0	19	45	44						
	APR	31	32	16	8	0	0	123	8	12	0	0	0	17	19	8						
	MAY	12	26	25	6	0	0	59	27	7	0	0	0	21	11	13						
	JUN	25	39	26	8	10	0	18	46	16	0	0	0	13	7	5						
	JUL	21	34	21	18	5	0	27	19	8	0	0	0	18	37	29						
	AUG	18	18	15	2	6	2	30	55	37	0	0	0	17	29	17						
	SEP	19	27	20	9	10	5	18	25	36	25	0	25	23	11	15						
	OCT	57	24	65	12	10	9	57	20	9	52	0	20	8	4	1	13	14	12	31	0	0
	NOV	32	54	51	12	16	19	71	77	111	0	0	0	26	24	16	8	9	14	41	8	0
	DEC	26	38	20	28	30	19	137	130	135	0	38	33	19	21	22	6	9	11	16	30	0
1994	JAN	24	25	19	4	14	15	43	45	35	30	37	25	20	19	13	7	8	8	6	36	20
	FEB	20	16	21	15	13	9	32	32	34	0	0	0	12	20	29	8	12	12	2	5	18
	MAR	28	27	31	9	7	4	28	25	35	0	0	0	22	28	25	5	5	4	25	25	0
	APR	33	27	30	10	8	6	25	9	23	7	3	2	9	19	19	29	8	6	8	4	10
	MAY	21	25	25	17	17	16	70	23	36	4	11	4	12	15	15	21	10	12	13	8	7
	JUN	25	39	26	19	19	18	76	38	50	8	12	9	30	18	18	4	11	8	11	15	18
	JUL	34	15	12	6	13	13	77	24	13	9	12	4	25	27	25	12	22	26	18	18	11
	AUG	24	18	17	23	20	20	27	27	12	22	14	8	77	32	35	8	22	14	52	20	19
	SEP	32	15	15	30	29	20	10	17	27	14	16	5	16	11	10	14	24	16	123	39	21
	OCT													28	39	35	3	3	20	151	64	53
	NOV													38	26	29	5	1	1	88	116	64
	DEC																14	7	10	21	25	23
1995	JAN																2	0	12	61	29	61
	FEB																12	15	5	35	34	64
	MAR																6	16	25	16	31	12
	APR																7	8	17	11	20	13
	MAY																6	7	8	3	17	12
	JUN																4	1	1	6	13	12
	JUL																23	4	10	9	10	10
	AUG																16	7	5	5	7	7
	SEP																13	13	12	11	7	6
Sum 1st 12m		250	265	196	166	190	186	347	275	204	25	0	25	205	223	183	135	154	143	346	208	124
Sum 2nd 12m		356	323	332	185	196	168	653	467	520	146	143	110	308	275	275	111	82	126	417	373	337
Sum 1st 11m		231	238	176	157	180	181	329	250	168	0	0	0	179	199	167	121	130	127	223	169	103
Sum 2nd 11m		324	308	317	155	167	148	643	450	493	132	127	105	270	249	246	98	69	114	406	366	331

Note D1 = DPT1 P3 = Polio3 M = Measles Shaded rows are months in which ITI training occurred Dashes indicate that clinic was not then in existence

Table A-3 Target Population in Program Health Centers and in Entire Province

Program Health Center	Official Target Population (12 Mo)			ITI Training Month	Estimated Target (12 Mo) [1,2]		Estimated Target (11 Mo) [1,3]	
	4/92–3/93	4/93–3/94	4/94–3/95		Before ITI	After ITI	Before ITI	After ITI
1 Air Solobar	699	590	660	Aug 93	653 6	619 2	599 1	567 6
2 Amahei	640	792	168	Mar 93	640 0	792 0	586 7	726 0
3 Benteng	758	602	723	Jun 93	719 0	632 3	659 1	579 6
4 Danar	274	274[4]	199[4]	Sep 93	274 0	236 5	251 2	216 8
5 Debut	324	313	168	Sep 93	318 5	240 5	292 0	220 5
6 Dofa	687	852	934	Dec 93	818 3	916 0	750 1	839 7
7 Jailolo	945	914	512	Aug 93	932 1	746 5	854 4	684 3
8 Patani	465	523	550	Sep 93	489 5	536 5	448 7	491 8
9 Rumat	267	245	197	Sep 93	256 0	221 0	234 7	202 6
10 Saketa	510	565	561	Sep 93	537 5	563 0	492 7	516 1
11 Waipia	202	208	—	Nov 93	206 0	181 3	188 8	166 2
12 Wairoro	163	179	142	Sep 94	171 0	160 5	156 8	147 1
13 Waisala	149	149	149[4]	Sep 94	149 0	149 0	136 6	136 6
14 Jerol[5]	320[4]	320	320[4]	Sep 93	320 0	320 0	293 3	293 3
15 Taberfane[5]	202[4]	202	202[4]	Sep 93	202 0	202 0	185 2	185 2
Total Program (rows 1–13)	6 083	6 202	4 963		6 165	5 994	5 651	5 495
Entire province[6]	57 830	56 611	53 900	Sep 93	57 221	55 256	52 453	50 651

[1] Estimated targets assume that official targets apply evenly through the year e g the before ITI 12 month period in row 1 (Air Salobar) includes 7 months during April 1992–March 1993 and 5 months during April 1993–March 1994=(7/12)x699 + (5/12)x590

[2] The before ITI 12 month period includes the 12 months culminating with the ITI training month and the ITI 12 month period includes the 12 months immediately following the ITI training month

[3] The before ITI 11 month period includes the 11 months immediately preceding the ITI training month and the after ITI 11 month period includes the 11 months immediately following the ITI training month

[4] Missing data Assumed to equal target population in adjacent years

[5] Jerol and Taberfane are not included in the calculations of program coverage because of missing data prior to program

[6] For purposes of estimating the before and after ITI periods for the entire province the ITI training month is assumed to have occurred in September 1993 which is the mode and rough midpoint of the ITI training months

Table A-4 Out-of-Pocket Costs for the ITI Programs

Program Health Center	Out of Pocket Cost[1]	
	RP	U S $[2]
1 Air Salobar	36,000	16
2 Amahei	36 000	16
3 Benteng	42,000	18
4 Danar	—[3]	—[3]
5 Debut	—[3]	—[3]
6 Dofa	290,000	125
7 Jailolo	160,000	69
8 Jerol	—[4]	—[4]
9 Patani	30 000	13
10 Rumat	—[3]	—[3]
11 Saketa	310,000	134
12 Taberfane	—[4]	—[4]
13 Waipia	54 000	23
14 Wairoro	250 000	108
15 Waisala	80,000	35
Sum	1 838 000	793
Average	122,533	53

[1] Out of pocket costs include transportation and per diem payments but not salary for either the trainer or host immunizer Per diem averaged about RP 10 000 per day ($4 30)

[2] Exchange rate in 1993 RP 1 000= $0 43

[3] Total cost for Danar Debut and Rumat together is RP 300 000 ($129)

[4] Total cost for Jerol and Taberfane together is RP 250 000 ($108)

Table A-5 Increase in Reported Doses and Coverage in the Program and Nonprogram Groups

		Target Population		Reported Doses				Unadjusted Coverage					Adjusted Coverage				All Coverage	
Antigen	Group	11 Mo Before	11 Mo After	11 Mo Before	11 Mo After	% Gain	Net % Gain	11 Mo Before (%)	11 Mo After (%)	% Gain	Net % Gain	Significance	11 Mo Before (%)	11 Mo After (%)	% Gain	Net % Gain	Percentile Gain	Net Percentile Gain
DPT1	Program	5 651	5 495	4 051	5 421	33 8	34 0	71 7	98 7	37 6	34 1	<0 001	48 7	75 7	55 4	50 7	27 0	23 9
	Nonprogram	47 044	45 366	41 222	41 135	0 2		87 6	90 7	3 5			64 6	67 7	4 7		3 0	
Polio3	Program	5 651	5 495	3 626	4 996	37 8	39 6	64 2	90 9	41 7	39 9	<0 001	41 2	67 9	65 0	62 5	26 8	25 3
	Nonprogram	47 044	45 366	38 765	38 064	1 8		82 4	83 9	1 8			59 4	60 9	2 5		1 5	
Measles	Program	5 651	5 495	3 276	4 593	40 2	42 5	58 0	83 6	44 2	42 9	<0 001	35 0	60 6	73 2	71 3	25 6	24 7
	Nonprogram	47 044	45 366	34 189	33 402	2 3		72 7	73 6	1 3			49 7	50 6	1 9		1 0	
Composite	Program	5 651	5 495	10 953	15 010	37 0	38 4	64 6	91 1	40 9	38 7	<0 001	41 6	68 1	63 6	60 4	26 4	24 6
	Nonprogram	47 044	45 366	114 176	112 601	1 4		80 9	82 7	2 3			57 9	59 7	3 2		1 8	

Note This table compares the number of reported age appropriate doses given unadjusted coverage and adjusted coverage in the 13 program health centers with the 95 nonprogram health centers in Maluku Province in the 11 month periods before and after the ITI training Percentage gain=(Doses after–Doses before) / (Doses before) Net percentage gain=(Percentage gain in program group–Percentage gain in nonprogram group) Unadjusted coverage=(Reported doses/Target population) Adjusted coverage=(Unadjusted coverage –23 percentage points) The difference in gain in unadjusted coverage is significant at the 0 001 level for all three antigens and their composite sum using a Chi square test with children as the unit of analysis The difference is even greater for adjusted coverage

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Table A-6 Reported Doses by Program Health Center within District

			Number of Reported Doses Given (11 months)								
			DPT1			Polio3			Measles		
District	Health Center	ITI Month	Before	After	Percentage Gain	Before	After	Percentage Gain	Before	After	Percentage Gain
Ambon	1 Air Salobar	8/93	385	404	5	315	385	22	302	346	15
	2 Benteng	3/93	437	465	6	420	446	6	361	374	4
Central Maluku	3 Amahei	6/93	503	827	64	425	775	82	473	686	45
	4 Waipia	9/93	179	270	51	199	249	25	167	246	47
	5 Waisala	12/93	223	406	82	169	366	117	103	331	221
North Maluku	6 Dofa	8/93	534	555	4	488	454	7	428	423	1
	7 Jailolo	9/93	686	918	34	665	381	81	644	912	40
	8 Saketa	9/93	329	643	95	250	450	80	168	493	194
Halamahera	9 Patani	11/93	891	324	40	238	308	29	176	317	80
	10 Wairoro	9/94	121	98	19	130	69	47	127	114	10
Southeast	11 Debut	9/94	179	154	16	117	215	84	106	113	7
	12 Rumat+Danar	9/93	244	357	46	210	298	42	221	238	4
Totals			4 051	5 421	34	3 626	4 996	38	3 276	4 593	40

Note This table shows the number of reported age appropriate doses given in each program health center in the 11 months before and 11 months after the ITI training Percentage gain equals 100 x (After–Before)/(Before)

Table A-7 Effect of Transportation Problems on Program Impact An Estimate of Potential Program Effectiveness

ITI	Health Center	11 Mo Target Population		Reported Doses (11 months)									Composite Coverage (11 months)						
				Before			After			Composite			Unadjusted			Adjusted			
		Before	After	D1	P3	M	D1	P3	M	Before	After	% Gain	Before (%)	After (%)	% Gain	Before (%)	After (%)	% Gain	Percentile Gain
1	Air Salobar	599	568	385	315	302	404	385	346	1 002	1 135	13	56	67	19	33	44	33	11
2	Amahei	587	726	503	425	473	827	775	686	1 401	2 288	63	80	105	32	57	82	45	25
3	Benteng	659	580	437	420	361	465	446	374	1 218	1 285	6	62	74	20	39	51	32	12
4	Debut	292	221	179	117	106	154	215	113	402	482	20	46	73	58	23	50	117	27
5	Dofa[1]	750	840	534	488	428	555	454	423	1 450	1 432	1	64	57	12	41	34	18	8
6	Jailolo	854	684	686	665	644	918	981	912	1 995	2 811	41	78	137	76	55	114	108	59
7	Patani	449	492	231	238	176	324	308	317	645	949	47	48	64	34	25	41	66	16
8	Saketa	493	516	329	250	168	643	450	493	747	1 586	112	51	102	103	28	79	189	52
9	Waipia	189	166	179	199	167	270	249	246	545	765	40	96	154	60	73	131	79	57
10	Wairoro[1]	157	147	121	130	127	98	69	114	378	281	26	80	64	21	57	41	29	17
11	Waisala	137	137	223	169	103	406	366	331	495	1 103	123	120	268	123	97	245	152	148
12	Rumat + Danar	486	419	244	210	221	357	298	238	675	893	32	46	71	53	23	48	106	25
All 13 centers																			
Total		5 652	5 496	4 051	3 626	3 276	5 421	4 996	4 593	10 953	15 010	37	65	91	41	42	68	64	26
Adjust coverage				49%	41%	35%	76%	68%	61%	42%	68%								
w/o Dofa or Wairoro																			
Total		4 745	4 509	3 396	3 008	2 721	4 768	4 473	4 056	9 125	13 297	46	64	98	53	41	75	83	34
Adjust coverage				49%	40%	34%	83%	76%	67%	41%	75%								

Notes This table calculates program impact with and without Dofa and Wairoro the two health centers with transportation problems in the year after ITI training thus estimating potential program impact Since the nonprogram centers experienced a percentage gain of 1% in reported doses +2 % in unadjusted coverage and +3 % in adjusted coverage the net percentage gains for the 11 health centers without transportation problems in reported doses unadjusted coverage and adjusted coverage are 47% (46+1) 51% (53 2) and 77% (80 3) respectively This compares to corresponding net percentage gains in all 13 health centers of 38% (37+1) 38% (40 2) and 58 % (61 3)

Figures do not always appear consistent due to rounding errors

D1 = DPT1 P3 = Polio3 M = Measles

[1] Program health centers that experienced transportation breakdown

Table A-8 Ranking of Program Health Centers in Their Districts by Reported Coverage

District	Program Health Center	Rank in District[1] At Start of ITI Training	Rank in District[1] Six Months after ITI Training	Percentile Increase[2]
Ambon	1 Air Salobar	15 / 16	14 / 16	6 3
	2 Benteng	14 / 16	13 / 16	6 3
Central Maluku	3 Amahei	22 / 45	7 / 45	33 3
	4 Waipia	41 / 45	12 / 45	64 4
	5 Waisala[3]	37 / 48	7 / 48	62 5
North Maluku	6 Dofa	21 / 24	11 / 24	41 7
	7 Jailolo	24 / 24	4 / 24	83 3
	8 Saketa	20 / 24	17 / 24	12 5
Halamahera	9 Patani	11 / 14	8 / 14	21 4
	10 Wairoro	8 / 14	4 / 14	28 6
Southeast[4]	11 Danar	15 / 24	5 / 25	42 5
	12 Debut	16 / 24	9 / 25	30 7
	13 Jerol	22 / 24	20 / 25	11 7
	14 Rumat	18 / 24	4 / 25	59 0
	15 Taberfane	12 / 24	8 / 25	18 0
Average percentile rank (100%=best)		23 3%	58 1%	34 8

[1] These two columns give the rank (numerator) out of all reporting health centers in the district (denominator) based on reported coverage in the past six months with a rank of 1 being the highest coverage

[2] Percentile increase equals 100 x [(1 rank after) (1 rank before)]

[3] Waisala s training month did not occur until 9/94 and the number of reporting health centers in the central district of Maluku increased from 45 to 48 during the period between the after ITI ranking of the other program health centers in the district and the Waisala training

[4] The number of reporting health centers in the southeast district increased by one between the before ITI and after ITI rankings

Table A-9 Correct Management Practices according to the Field Survey

Type of Practice	Number of Program Health Centers with Correct Practice, by Type of Practice		
	Before	After	Gain
1 Refrigerator temperature okay (2–8 C°)	11	11	0
2 Refrigerator temperature recorded	6	11	5
3 No damaged vaccine	12	11	1
4 All vaccine stored correctly	10	11	1
5 Shake test okay	11	12	1
6 Information recorded past 3 months	5	9	4
7 Information sent to subdistrict	3	5	2
8 Immunize when child >12 months	10	11	1
9 Immunize when child has fever	4	9	5
10 Immunize when child has diarrhea	4	10	6
11 Immunize when child has a cold	5	11	6
12 If only one child still open ampule and vaccinate	8	11	3
Average number of correct practices per health center	7 4	10 2	2 8

Note Results from the Field Survey of Management Practices in 12 ITI program health centers showing the number of centers performing each immunization practice correctly before and after the ITI training Practices 1 2 4 6 and 7 in this table correspond to practices 1 2 3 4 and 5 respectively in table A 10

Table A-10 Correct Management Practices according to the ITI Trainers

Type of Practice	Number of Program Health Centers with Correct Practice, by Type of Practice		
	Before	After	Gain
1 Refrigerator temperature okay (2–8 C°)	10	11	1
2 Refrigerator temperature recorded	9	11	2
3 All vaccine stored correctly	8	11	3
4 Information recorded in past 3 months	11	11	0
5 Information sent to subdistrict	4 5	7	2 5
6 Identify absent babies at Posyandu and go after them	7	11	4
7 Use vaccine supply book	7	11	4
8 All instruments sterilized	11	11	0
Average number of correct practices per health center	8 5	10 5	2 0

Note Results from the ITI trainer assessments in 11 ITI program health centers showing the number of centers performing each immunization practice correctly before and after the ITI training Practices 1 2 3 4 and 5 in this table correspond to practices 1 2 4 6 and 7 respectively in Table A 9

Table A-11 Change in Immunizer Resources before and after the ITI Training

Program Health Center	Confounder: Replaced Immunizer	Confounder: Different Staff Time	Reported Doses—Composite of DPT1, Polio3, and Measles: Replaced Immunizer, Before	Replaced Immunizer, Gain	Same Immunizer, Before	Same Immunizer, Gain	Different Staff Time, Before	Different Staff Time, Gain	Same Staff Time, Before	Same Staff Time, Gain
1 Air Salobar	Yes		1 002	133					1 002	133
2 Amahei					1 401	887			1 401	887
3 Benteng	Yes		1 218	67					1 218	67
4 Debut	Yes	Yes	402	80			402	80		
5 Dofa[1]					1 456	165			1 450	18
6 Jailolo	Yes		1 995	816					1 995	1 466
7 Patani					645	304			645	304
8 Saketa					747	839			747	839
9 Waipia					545	220			545	220
10 Wairoro[1]					378	97			378	97
11 Waisala		Yes			495	608	495	608		
12 Rumat+Danar	Yes		675	218					675	218
All 13 centers										
Sum	5	2	5 292	1 314	5 661	2 743	897	688		
Average			1 058	263	809	392	449	344		
Percentage gain				24 8%		48 5%		76 7%		
Without Dofa or Wairoro										
Sum	5	2	5 292	1 314	3 833	2 858	897	688	8 228	4 134
Average			1 058	263	767	572	449	344	1 029	517
Percentage gain				24 8%		74 6%		76 7%		50 2%

Note Figures for reported doses are for the 11 months preceding and 11 months following the ITI training month

[1] Dofa and Wairoro are the two health centers with transportation problems in the year following the ITI training The percentage gains were significantly different (at the 0 001 level) for both replaced immunizer and staff time with and without Dofa and Wairoro

Annex B. Derivation of Corrections to Reported Coverage

Summary of Household Survey Results

PCI completed two Maluku provincewide sample surveys in 1994 and 1995 using the standard WHO 30-cluster EPI household immunization survey methodology Each survey obtained immunization data on 240 children aged 12 to 23 9 months The 1994 survey was done in May 1994 and the 1995 survey was done January 16 to February 10, 1995 The cluster surveys provide estimates for three different definitions of coverage (1) "vaccinations by survey" is defined as the fraction of the children in the survey sample, aged 12 to 23 9 months at the time of the survey interview, who were vaccinated by the time of the survey, (2) "vaccinated by first birthday" is the fraction of sample children vaccinated by their first birthday, and (3) "correctly" vaccinated is the fraction vaccinated according to the recommended schedule, including all vaccines by the first birthday, measles after 9 months of age, and proper spacing between vaccinations The survey only counted vaccinations that were verified (including the date) by the child's health card or the health clinic's immunization registry

Results of the 1994 and 1995 surveys for children vaccinated "fully" and for three antigens (DPT1, polio3, and measles) are summarized in table B-1 Fully vaccinated refers to children who received all eight childhood vaccinations (DPT1/2/3, BCG, polio1/2/3, and measles after age 9 months) In the final report of the surveys, results for "by 1st birthday" and "correctly" vaccinated were available only for fully vaccinated children

Coverage in 1994 was higher than in 1995 because of the special effort made in 1993 and early 1994 to reach national targets

Strategy for Estimating Corrections

Reported coverages in the provincial immunization information system are substantially higher than those obtained from the 1994 and 1995 surveys It is generally agreed that the results obtained from the population-based household surveys are more accurate than those in the administrative information system, and so coverage estimates obtained from the 1994 and 1995 household surveys are assumed to be

Table B-1 Summary of Key Results from 1994 and 1995 Coverage Surveys

	Percentage Vaccinated (Coverage)	
Antigen / Definition	**1994**	**1995**
DPT1 / by survey	74	67
Polio3 / by survey	71	59
Measles / by survey	69	57
Fully / by survey	64	53
Fully / by 1st birthday	60	47
Fully / correctly	52	43

Source PCI/Indonesia and Ministry of Health Maluku Province Baseline Survey Maluku Province Indonesia Child Survival X January 16–February 10 1995 Page 21

the correct estimates Therefore, the reported coverages are adjusted downward to make them consistent with the coverages obtained in the surveys In theory, the survey coverages for the different antigens can be subtracted from the corresponding provincewide reported coverages in the information system to obtain antigen-specific corrections to the reported coverages The correction is defined as the average difference in percentage points by antigen The correction can then be subtracted from the reported coverages in the before ITI and after ITI time periods to obtain the adjusted coverage However, the annual time periods used by the information system do not correspond to the periods when the surveyed children were immunized, nor do the definitions used by the survey with respect to age-appropriateness correspond in all cases with the definition used by the information system Therefore, these issues must be resolved The steps taken to resolve the issues and obtain the corrections are as follows

1 Determine when the children in the 1994 and 1995 surveys actually received vaccinations

2 Estimate the provincewide reported coverage during the period when the surveyed children actually received vaccinations (from step 1)

3 Transform all survey coverages into age-appropriate coverage that corresponds to the definitions used by the immunization information system

4 Subtract the age-appropriate survey coverages (from step 3) from the corresponding reported coverages for the same time period (from step 2) to obtain the corrections to reported coverage

Dates When Survey Vaccinations Actually Were Given

The children in the survey samples actually received their vaccinations sometime during the 24 months before the survey, although the period differs by antigen DPT1 and polio3 are assumed to have occurred in the preceding 24 months (May 1, 1992, to May 1, 1994, for the 1994 survey and May 1, 1993, to May 1, 1995, for the 1995 survey), which reflects the extremes of a 12-month-old child vaccinated just a few days before the survey to a 23 9-month-old vaccinated just after birth Of course, this assumption is not accurate, especially for polio3, but turns out to be sufficient for our purposes Measles vaccinations are assumed to have occurred in the 16 months preceding the survey (May 1, 1993, to May 1, 1994, for the 1994 survey and September 1, 1993, to September 1, 1995, for the 1995 survey), reflecting the age-appropriate standard of not vaccinating for measles until age 9 months

Transforming Reported Coverage to Survey Coverage Time Periods

In the immunization information system, doses are reported for the month in which they were given, but coverage is estimated on an annual basis for the 12-month period from April 1 through March 31 of the following year because the size of the target population (the denominator) is estimated on an annual basis Table B-2 presents provincewide estimates of reported coverage from the information system for the three years needed to span the dates when the children in the 1994 and 1995 surveys received vaccinations It also gives the number of months that each of the three information system years overlaps the period when surveyed children were vaccinated

Table B-2 Coverage by Annual Time Periods

Information System Year	Reported Coverage Information System			Number of Months When Survey Vaccines Given			
	DPT1	Polio3	Measles	1994 (24 Mo)	1994 (16 Mo)	1995 (24 Mo)	1995 (16 Mo)
4/1/92–3/31/93	79 2%	74 5%	72 5%	11	3	3	0
4/1/93–3/31/94	94 3%	88 2%	70 7%	12	12	12	7
4/1/94–3/31/95	90 2%	82 2%	80 2%	1	1	9	9
				24	16	24	16

Table B-3 presents the reported coverages from the information system transformed to correspond to the periods when the surveyed children received vaccinations, using the data from table B-2

Transforming Survey Estimates to Age-Appropriate Coverage

As seen in table B-1, estimates of full coverage received by the time of the survey are higher than coverage received by the first birthday or "correctly," as expected The percentile differences between "by first birthday" and "by survey" for full vaccination are assumed to apply to DPT1 and polio3, and the percentile difference between "correct" and "by survey" is assumed to apply to measles because most of the difference between "correct" and "by first birthday" was due to early (before 9 months) measles vaccinations Table B-4 applies these percentile corrections to the 1994 and 1995 survey coverages to obtain survey coverages that correspond to the reported coverages with respect to definition

Table B-3 Provincewide Reported Coverage for Period When Surveyed Children Received Vaccinations

Survey	Uncorrected Reported Coverage Corresponding to Survey Periods		
	DPT1	Polio3	Measles
1994	87 2 %	81 7 %	71 6 %
1995	90 9 %	84 2 %	76 0 %
Average	89 05%	82 95%	73 8 %

Note The results in this table are obtained from the data in Table B 2 For example DPT1 for the 1994 survey is calculated as follows (79 2 x 11/24) + (94 3 x 12/24) + 90 2 x 1/24)=87 2 and measles for the 1995 survey as (72 5 x 0/24) + (70 7 x 7/16) + 80 2 x 9/16)=76 0

Table B-4 Average Survey Coverage for Different Definitions

Vaccine	By Survey	By 1st Birthday	Correct
Fully	58 5% *	53 5% *	47 5% *
DPT1	70 5% *	65 5% **	59 5%
Polio3	65 0% *	60 0% **	54 0%
Measles	63 0% *	58 0%	52 0% **

Note Figures marked with a single asterisk (*) are obtained from table B 1 The figures for DPT1 polio3 and measles in the by 1st birthday and correct columns are obtained by reducing the corresponding figures in the by survey column by the same amount as the 'fully row reduces namely 5 percentage points in the by 1st birthday column and 11 percentage points in the correct column Figures marked by two asterisks (**) are the estimates used

Subtract Corresponding Survey Coverages from Reported Coverages

To obtain the correction figures for the three antigens, the age-appropriate survey coverages derived in table B-4 are subtracted from the reported coverages for the corresponding time period derived in table B-3 The results are presented in table B-5 Note that the three corrections cluster closely around 23 percentage points Therefore, the general correction will be 23 percentage points, and this amount will be subtracted from reported coverage in the information system to obtain adjusted coverage

Table B-5 Estimate of Coverage Corrections by Antigen

Antigen	Reported Coverage (from Table B-4)	Age-Appropriate Survey Coverage (from Table B-3)	Correction (in Percentage Points)
DPT1	89 05%	65 5%	23 55
Polio3	82 95%	60 0%	22 95
Measles	73 80%	52 0%	21 80